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(54) **TURBOCHARGED ENGINE WITH A SENSOR DEVICE IN THE TURBOCHARGER HOUSING**

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| ***F02B 37/18*** | (2006.01) |
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| ***F01D 21/00*** | (2006.01) |

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USPC ........................................................ 60/605.1
See application file for complete search history.

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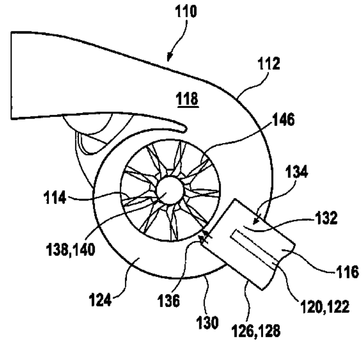
(57) **ABSTRACT**

A turbocharger for use in an internal combustion engine has at least one turbocharger housing, at least one compressor situated inside the turbocharger housing, and at least one turbine situated inside the turbocharger housing. In addition, the turbocharger has at least one sensor device for detecting at least a portion of a gas component of an exhaust gas of the internal combustion engine. The sensor device is at least partially integrated into the turbocharger housing.

**11 Claims, 4 Drawing Sheets**



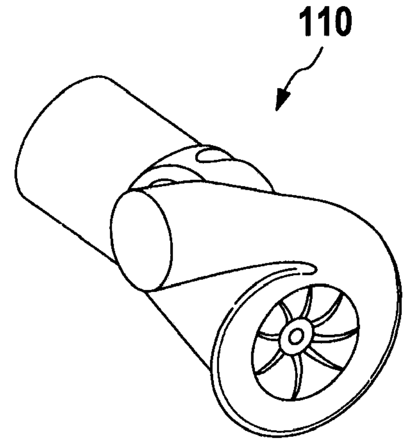



FIG. 1A

FIG. 1B

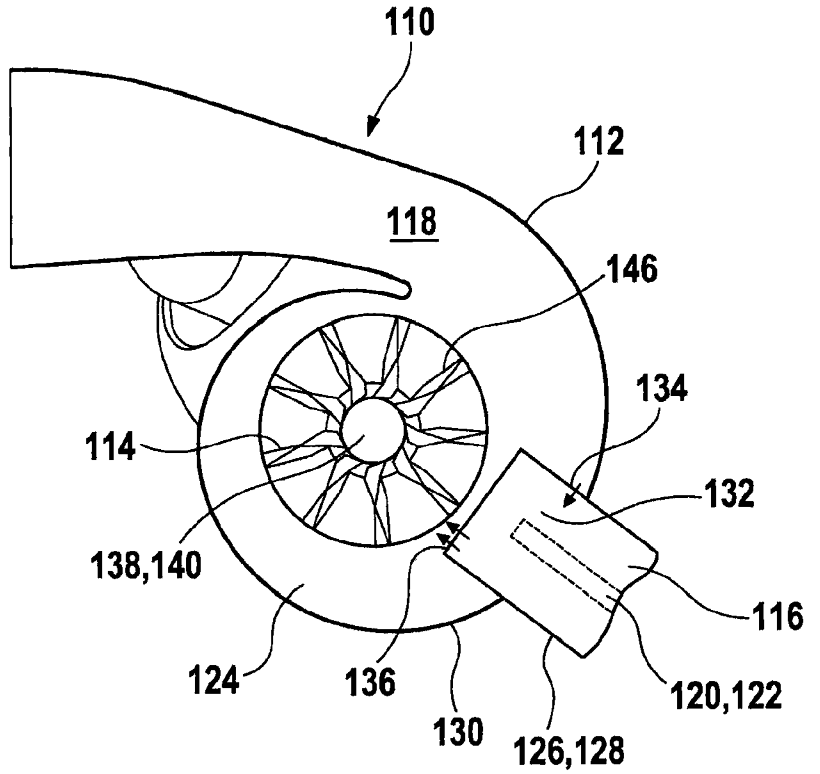

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FIG. 2

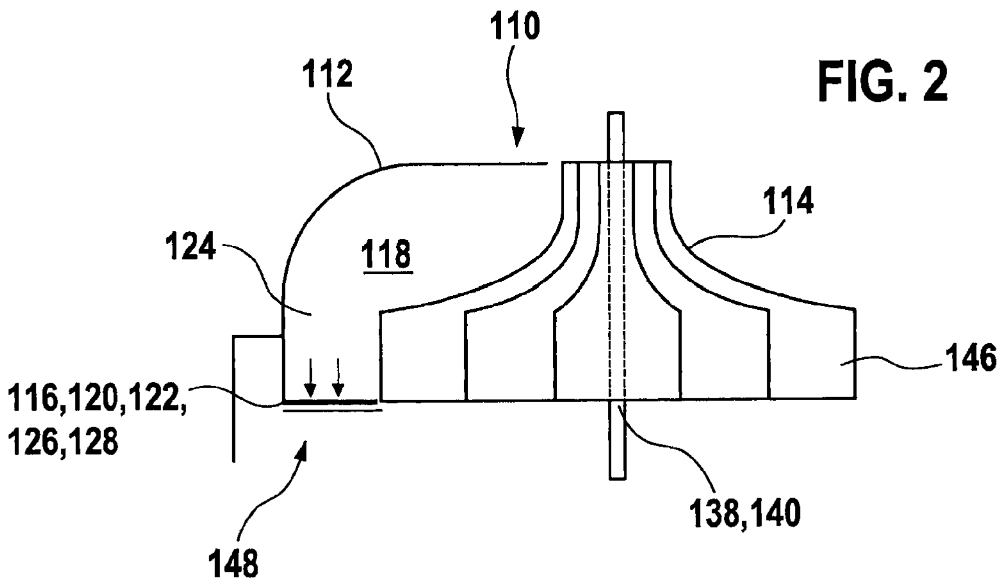
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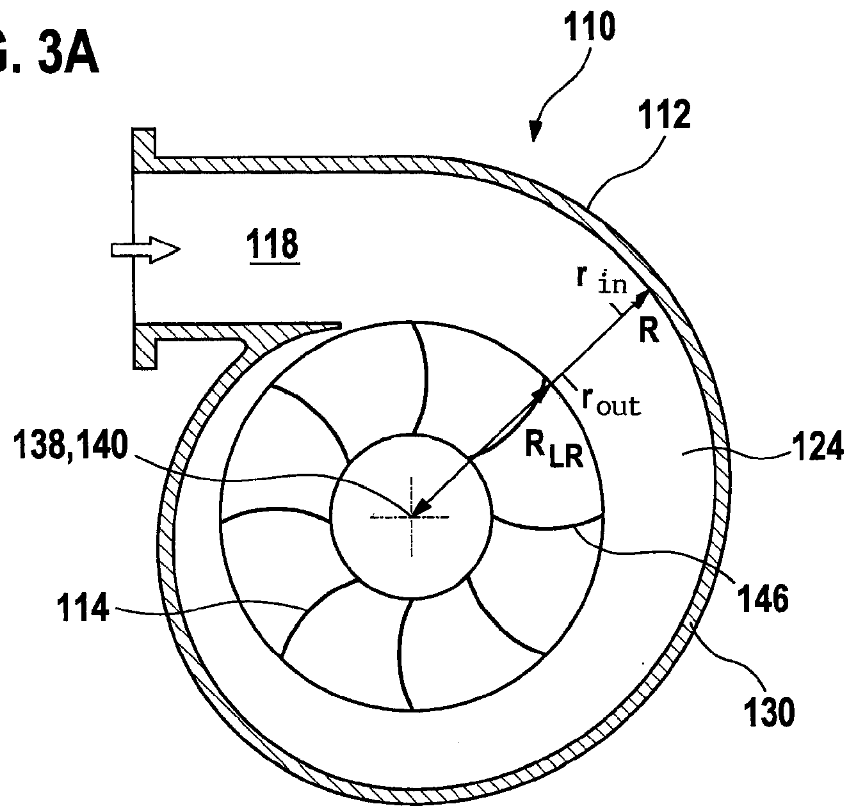
FIG. 3A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112
118
r in
R
r out
138,140
R LR
124
114
146
130

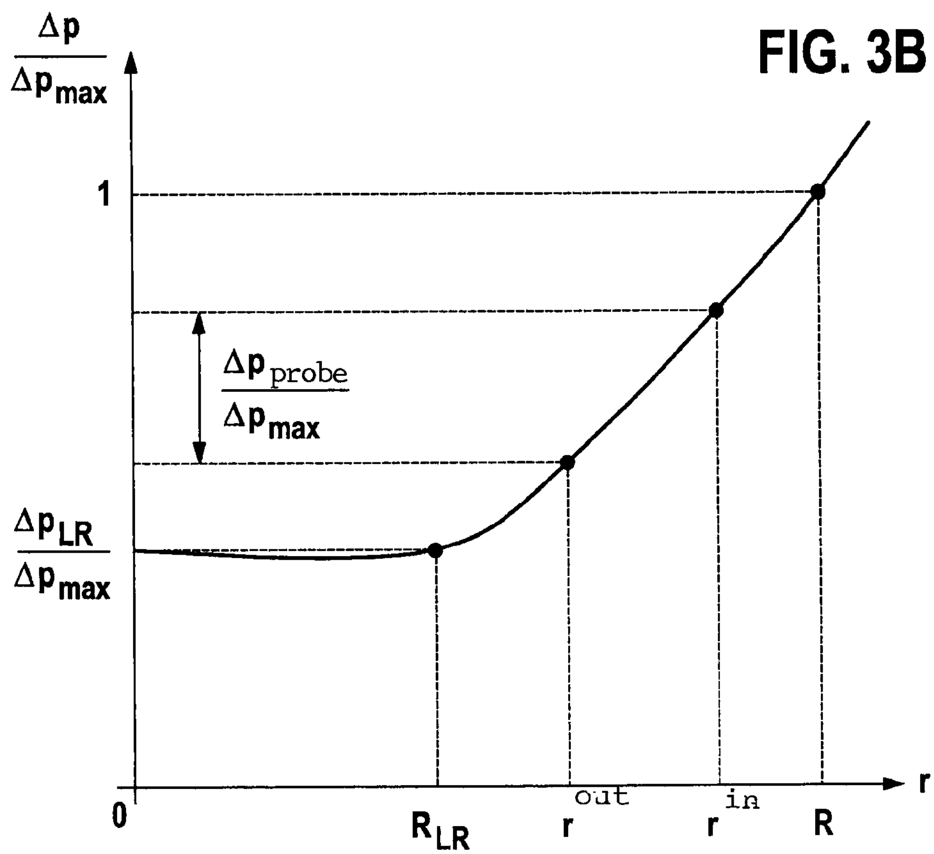

Δp
Δp max
1
Δp probe
Δp max
Δp LR
Δp max
0
R LR
r out
r in
R
r

FIG. 3B

FIG. 4

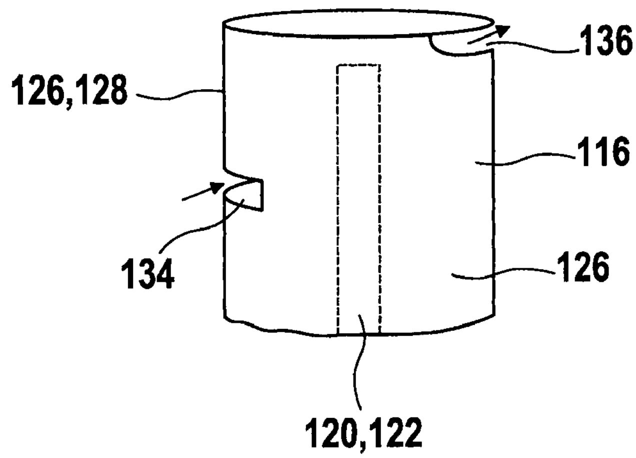
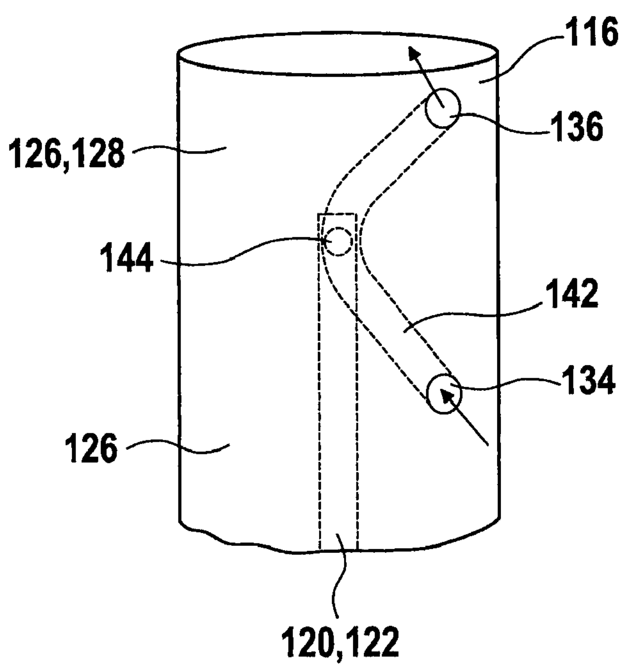

136
126,128
116
134
126
120,122

FIG. 5


116
126,128
136
144
142
134
126
120,122

# TURBOCHARGED ENGINE WITH A SENSOR DEVICE IN THE TURBOCHARGER HOUSING

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a turbocharger for an internal combustion engine.

2. Description of the Related Art

Sensor elements for detecting at least a portion of at least one gas component of a gas, such as an exhaust gas, in a measuring-gas chamber, especially in an exhaust-gas tract, are known from the related art. For example, such sensor elements are described in Robert Bosch GmbH: Sensors in the Motor Vehicle, 1st edition 2010, pages 160-165. The sensor elements may be used in the automotive field, for example. The measuring gas chamber in particular could be the exhaust-gas tract of a combustion engine, for instance, and the sensor element a lambda probe. The core of the sensor element, especially the lambda probe, usually is a technical ceramic, which may be destroyed if, for instance, large mechanical tensions occur in the sensor element. For example, tensions, especially mechanical tensions, could be produced by local cooling of the, in particular, hot technical ceramic, for example, especially a ceramic, due to impinging water drops, for instance. Sensor elements known from the related art are normally situated within the exhaust-gas tract in the exhaust direction, especially in the flow direction of the exhaust gas, downstream from a turbocharger and preferably upstream from a catalytic converter, especially a three-way catalytic converter. Water loading, especially in conjunction with an increasing likelihood of impinging water drops, is usually greatest during a cold engine start. In an engine operation with a cold exhaust-gas tract, e.g., during the cold engine start, exhaust-gas moisture may condense on walls, the exhaust-gas tract, for example, encompassing at least one cylinder outlet, at least one manifold, at least one turbocharger, especially at least one exhaust turbocharger, and at least one three-way catalytic converter. An exhaust gas mass flow can carry exhaust gas condensate along, especially in such a way that a high moisture load of a downstream lambda probe often comes about as a result.

The related art describes various strategies for protecting the sensor element, especially the functional ceramic, from damage, in particular damage resulting from stresses. For example, the technical ceramics may be heated to operating temperature only after a so-called dew point end instant has been reached. In a cold state, especially prior to the dew point end, the mechanical stresses in the sensor element caused by the admission of water are generally non-critical. One particular disadvantage of this strategy is a late operating readiness of the sensor element, especially a probe, following the engine start.

In another strategy, the sensor element may be enclosed by a water-proof protective coat, for example, which is able to distribute local cooling, preferably across a large surface. One particular disadvantage in this case may be a limited absorption capacity of the protective coat with regard to moisture. Another disadvantage may be an increased heating power requirement, especially if large exhaust gas mass flows are involved.

The classic installation position of the sensor element, especially the lambda probe, known from the related art, such as between the turbocharger, especially the exhaust-gas turbocharger, and the three-way catalytic converter, may be disadvantageous from the aspect of space utilization. Another, preferably fixated and/or protected installation position of the sensor element, in particular the lambda probe, is desirable. Other installation positions for sensors, especially sensors in the broadest sense, are known from the related art.

Published German patent application document DE 10 2006 058 539 A1 describes a self-ignition engine having a pressure-based combustion control. For example, this laid-open publication describes that an engine may be equipped with exhaust-gas/fuel-ratio sensors, e.g., in an exhaust-gas manifold.

Published German patent document DE 601 02 337 T2, for example, describes a system for aiding in the regeneration of a particle filter in a self-igniting internal combustion engine. In FIG. 1 of this translation of a European patent publication, a lambda probe is disclosed, which is schematically situated between a Diesel engine and a turbocharger, which is followed by an oxidation catalytic converter.

Published German patent document DE 601 30 851 T2 describes a turbocharger control unit. It is stated that the turbocharger system has one or more sensors.

Published German patent application document 10 2008 034 680 A1 describes a cooled turbocharger housing having one or more electronic devices. In one specific development according to the present invention, it is indicated that the electronic device is a sensor device, for instance.

An orientation of a shield tube with respect to the sensor element, especially to a gas entry hole of the sensor element, is generally variable in the related art, for construction-related reasons. A preferably fixed orientation of sensor element/shield tube is desirable. Reaching the operational readiness of the sensor element, especially the lambda probe, more rapidly following an engine start would be desirable. To do so, the admission of water to the sensor element, especially the lambda probe, after the engine start preferably should be reduced. At the same time, for example, a high dynamic response of the sensor element, especially a high dynamic response of the lambda probe, to a change in the oxygen partial pressure should be ensured. In addition, it would be desirable to ensure a uniform and/or protected installation position and/or installed state of the sensor element, especially the lambda probe, in various space concepts.

## BRIEF SUMMARY OF THE INVENTION

Therefore, a turbocharger for use in an internal combustion engine is provided, which specifically avoids, or at least reduces, the disadvantages known from the related art, especially the afore-described disadvantages, of components of an exhaust tract. The internal combustion engine basically may be a device which converts energy from a fuel into mechanical energy by way of combustion processes, e.g., at least one oxidation reaction. The internal combustion engine preferably may be a motor vehicle. The turbocharger has at least one turbocharger housing. The turbocharger housing in particular may be part of a turbocharger, the turbocharger housing preferably being at least partially an outer surface of the turbocharger or including an outer surface of the turbocharger, or a part thereof. Furthermore, the turbocharger includes at least one compressor situated inside the turbocharger housing, and at least one turbine situated inside the turbocharger housing. The compressor in particular may be a device set up to steer air, especially oxygen, into at least one engine of the internal combustion engine, and/or to aspirate air, especially oxygen, from the ambient air, and/or to pump it into the engine. In particular, the compressor may be configured to compress air. The compressor in particular may include at least one, preferably multiple, turbocharger blade(s), which could be disposed in such a way that a rotor is formed. The rotor may be connected to the turbine, in particular via a shaft, especially via an axle, preferably in such a way that a rotation of the turbine is transmitted to the compressor, in particular the rotor of the compressor, such that the rotor rotates and air is able to be aspirated from the environment and/or pumped into the engine and/or compressed. Preferably, the turbine may be a system of at least one turbocharger blade, such that the system forms a rotor. The turbine in particular may be configured to be set into rotation by an inflow of exhaust gas, for example in order to operate the compressor, preferably via the axle. In addition, the turbocharger includes at least one sensor device for acquiring at least a portion of a gas component of an exhaust gas of the internal combustion engine.

The sensor device, especially a lambda probe, is at least partially integrated into the turbocharger housing. "Integrated" in particular may be understood to mean that the sensor device is at least partially connected to the turbocharger housing, directly or indirectly. For example, "integrated" may also mean that the sensor device is at least partially situated inside the turbocharger housing.

The sensor device may at least partially be disposed inside a volute of the turbine. The volute preferably could be an exhaust-gas supply line to the turbine, which is designed to resemble a spiral. For example, the volute may be an exhaust-gas supply line to the turbine, the supply line at least partially having a spiral-shaped design. A cross-section, especially a diameter, of the supply line and/or the extension of the volute may taper in the flow direction, in particular.

The turbocharger may include at least one wastegate access. The wastegate access in particular may be a device for controlling the exhaust-gas flow, e.g., the exhaust-gas mass flow, through the turbocharger, especially through the volute and/or the turbine. Without wastegate access, the turbine would usually rotate very fast, e.g., in an operation of the internal combustion engine at full throttle. The rapid rotation in particular would cause much air to be compressed, so that the engine preferably would become more and more powerful. A wastegate access in particular may be set up to short-circuit an exhaust-gas supply line to the turbocharger, with an exhaust-gas discharge, especially out of the turbocharger. The wastegate access in particular may be situated between the manifold and the turbocharger, especially in an exhaust-gas system. Preferably, the wastegate access may include a flap valve, and an angle of the flap valve is able to be opened and/or closed in such a way that the inflow of exhaust gas to the turbocharger, especially the exhaust gas mass flow, is controllable. The sensor device may be at least partially positioned behind, especially behind in the flow direction of the exhaust gas, the wastegate access, preferably in an exhaust gas supply line to the turbine. For example, the sensor device may at least partially be situated between the wastegate access and the turbocharger and/or the volute, and/or the turbine, and/or the exhaust-gas outlet of the turbocharger.

For example, the sensor device is connectable to the turbocharger housing in reversible manner. A "reversible connection" may be understood to mean that the sensor device is able to be uninstalled, especially in such a way that the sensor device and/or the turbocharger housing and/or another part of the turbocharger will not be damaged and/or damaged in such a way that the damage is able to be repaired without particular expense. In particular, a separate exchange of the sensor device and/or the turbocharger housing is possible in the case of a reversible connection.

For example, the sensor device is able to be screwed to the turbocharger housing. The sensor device in particular may be screw-fitted to the turbocharger housing using at least one cap screw and/or at least one screw cap. Screw-fitting in this case may describe an affixation by means of at least one screw and/or at least one nut, in particular.

For instance, the screw coupling may include at least one further part, e.g., at least one washer and/or at least one seal.

In principle, the sensor device is also able to be joined to the turbocharger housing and/or another component of the turbocharger by some other connection technique, e.g., by welding and/or bonding and/or press-fitting and/or riveting and/or nailing and/or soldering and/or by direct screw-fitting of the turbocharger housing with the sensor device, using at least one thread on the turbocharger housing and/or the sensor device, for example. The cap screw and/or the screw cap, for instance, may be a screw provided with at least one cavity, especially a centered tubular opening, and/or at least one thread, preferably on the outside and/or inside, such as at least one internal thread and/or at least one external thread. A screw joint in particular may describe an affixation in which at least one part of the sensor device and/or at least one section of the turbocharger housing and/or the cap screw and/or the screw cap execute(s) at least one rotation and/or at least one torsion during the assembly.

The sensor device may include at least one sensor element. For example, the sensor device and/or the sensor element could be a lambda probe, especially as described in Robert Bosch GmbH: Sensors in the Motor Vehicle, 1st edition 2010, pages 160-165. The turbocharger according to the present invention in particular may include at least one sensor element, preferably at least one lambda probe, in a protected installation position. For example, the sensor element can have at least two electrodes and at least one solid electrolyte connecting the electrodes, such as a technical ceramic. A first electrode, which may be acted on by the exhaust gas and/or by some other gas, and at least one second electrode may be included in the sensor element. The sensor element may be a lambda probe, in particular, e.g., a lambda probe having one cell and/or a lambda probe having two cells. The sensor element preferably could be a broadband lambda probe. The first electrode and the second electrode are able to be connected via the at least one solid electrolyte. The solid electrolyte in particular may be a ceramic solid electrolyte, e.g., zirconia dioxide, especially yttrium-stabilized zirconia dioxide (YSZ) and/or scandium-doped zirconia dioxide (ScSZ). The first electrode preferably is an outer pumping electrode. The second electrode preferably may be an inner pumping electrode, for instance. The terms "first" and "second" in this case are expressions which contain no information about a particular sequence. For example, further electrodes, such as at least one third electrode, e.g., at least one reference electrode, may be included in the sensor element. An electrode, for instance the first electrode and/or the second electrode and/or the third electrode, in particular may be a component to which an electrical voltage and/or an electrical current is able to be applied. The sensor element, especially the lambda probe, preferably is able to generate at least one sensor signal, e.g., an electrical pumping current and/or a Nernst voltage. For example, using a characteristics curve, the proportion, especially an oxygen concentration, in the exhaust gas is inferable from the sensor signal, preferably if the overall pressure is known. The component is able to be recorded directly or indirectly, for example. For instance, it is possible to detect an oxygen partial pressure in direct manner and to use it, for instance in conjunction with an overall pressure, to ascertain the oxygen component and/or an oxygen percentage. The gas component preferably may be oxygen, especially molecular oxygen. The component in particular may be a percentage and/or a partial pressure. The exhaust gas in particular may be a mixture, especially a gas mixture, e.g., of air and/or combustion gases, such as from the engine of the internal combustion engine.

The sensor device optionally may include at least one shield tube. The shield tube preferably could be at least one guide vane mechanism. The shield tube and/or the guide vane mechanism generally may be a housing of the sensor device. The sensor element may at least partially be disposed inside the shield tube. For instance, it is also possible for the sensor element to be completely disposed inside the shield tube, it particularly being possible for the sensor element to be surrounded by the shield tube either completely or partially.

In a preferred manner, the shield tube may be developed to guide condensate past the sensor element. In principle, the condensate may be a fluid, preferably a liquid, especially water, the fluid possibly being condensed from the exhaust gas due to cooling, for example. To "guide past" in this case means that the condensate passes the sensor device without making contact with the sensor element, especially the first electrode and/or the second electrode and/or the third electrode and/or the solid electrolyte. The shield tube preferably is able to be connected to the turbocharger housing and/or the sensor element in reversible manner. For example, a "reversible connection" may be understood to mean that the shield tube and/or the turbocharger housing and/or sensor element are/is able to be uninstalled, especially in such a way that the shield tube and/or the turbocharger housing and/or the sensor element and/or some other part of the turbocharger will not be damaged and/or damaged only to such an extent that the damage is able to be repaired quite easily. A reversible connection in particular may allow an individual exchange of the shield tube and/or the turbocharger housing and/or the sensor element.

The shield tube in particular may be reversibly connected and/or fixed in place in flush manner, e.g., flush with the wall, e.g., on a rear volute wall inside the turbocharger, especially using a cap screw and/or screw cap.

The shield tube may include at least one inlet opening and/or at least one outlet opening. The inlet opening preferably may be an opening for routing the exhaust gas into the shield tube, preferably toward the sensor element. The outlet opening preferably may be an opening for discharging the exhaust gas from the shield tube. The inlet opening and/or the outlet opening, for example, may be holes and/or round and/or oval and/or rectangular and/or square and/or slotted openings. The openings may basically also have other forms. Preferably, the inlet opening may be separate from the outlet opening. The inlet opening and the outlet opening may basically overlap at least partially or be identical. The inlet opening preferably may be situated closer to a wall, e.g., an outer wall, of the volute than the outlet opening. Preferably, the inlet opening may be situated in a region of the exhaust-gas flow that has a lower flow velocity, e.g., a lower exhaust-gas flow velocity, than the flow velocity of the exhaust gas at the outlet opening. Preferably, the inlet opening may be situated at a radial distance $r_{ein}$ from a center point of the turbine. A radial distance in particular may be a distance between the center point of the turbine, e.g., a point on the axle and/or the shaft, and a point in a plane parallel to a rotation plane of the turbine that preferably also includes the center point. The discharge opening preferably may be situated at a radial distance $r_{aus}$ from the center point of the turbine. $r_{ein}$ preferably may be greater than $r_{aus}$. Since a lower pressure usually prevails at $r_{aus}$ than at $r_{ein}$, the exhaust gas may be driven through the shield tube, in particular past the sensor element, by a chimney effect.

The inflow opening and the discharge opening, for instance, may be situated on the same side or on opposite sides of the shield tube. A projection of the inlet opening together with a projection of the outlet opening, onto a plane perpendicular to a longitudinal axis of the shield tube, forms an angle with respect to the intersection of the longitudinal axis with the plane; given a placement on opposite sides, the angle amounts to between 150° and 110°, in particular between 170° and 190°, especially preferably, approximately 180°. If the inflow opening and the discharge opening are on the same side, for example, the angle is between −30° and +30°, in particular between −10° and +10°, especially preferably, approximately 0°.

The inflow opening and the discharge opening may be interconnected, for instance via a bypass. If the inflow opening and the discharge opening are connected to each other via a bypass, the inflow opening and the discharge opening preferably are situated on the same side, e.g., on a side of the shield tube that is directly exposed to the flow of the exhaust gas. If the shield tube does not have a bypass, it may be preferred to place the inflow opening on the side on which the exhaust gas flow arrives, and the discharge opening on the opposite side, for example. The bypass basically may be a connection that carries the exhaust gas between the inflow opening and the discharge opening. For example, the connection may be developed as pipe, such as a bent pipe. Preferably, the bypass may guide the exhaust gas from the inflow opening to the discharge opening via at least a portion of the sensor element, for instance in order to have the exhaust gas act on the first electrode and/or the second electrode.

The turbocharger according to the present invention may have numerous advantages over known turbochargers. Since the turbocharger includes the sensor device, the portion of the gas component of the exhaust gas, e.g., an exhaust gas value, is able to be measured directly and/or more rapidly and/or on a continuous basis. For example, according to SULEV (Super Ultra Low Emission Vehicle) requirements, acquisitions and/or measurements of exhaust-gas values should start immediately after an engine is started up, since 80% of emissions are generally released during that process. This SULEV requirement, for instance, is able to be satisfied when using the turbocharger according to the present invention. For instance, compliance with the SULEV standard makes it possible to reduce emissions. The size of the catalytic converter, and thus the system cost, is able to be reduced if the sensor device, especially the lambda probe, is at least partially integrated into the turbocharger housing, for instance through a direct connection of a catalytic converter to the exhaust-gas turbocharger. For example, the partial pressure and a temperature are able to be measured in an at least approximately continuous manner. Additional shield tubes or welding seams, for example, may be dispensed with in the present invention, which is why temperature stability and/or a high dynamic response are/is able to be ensured, for instance because the bypass may assume the tasks of a second shield tube, in particular. Furthermore, a lower heating voltage requirement (UH) and/or greater thermoshock robustness are/is able to be provided by the present invention. In addition, a uniform placement of the sensor element, especially the lambda probe, is possible, for instance for various applications by users and/or manufacturers.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A shows a perspective view of an exemplary embodiment of a turbocharger according to the present invention.

FIG. **1**B shows a cross-sectional drawing of the exemplary embodiment of the turbocharger of the present invention according to FIG. **1**A.

FIG. **2** shows a cross-sectional drawing of another exemplary embodiment of a turbocharger according to the present invention.

FIG. **3**A shows a schematic representation of a turbocharger according to the present invention, to clarify the pressure distribution.

FIG. **3**B shows an illustration of the pressure distribution in a volute of a turbocharger according to the present invention.

FIG. **4** shows an illustration of an optional development of a sensor device, as it may be provided in an exemplary embodiment of a turbocharger according to the present invention.

FIG. **5** shows another illustration of an optional development of a sensor device, as it may be provided in an exemplary embodiment of a turbocharger according to the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

FIG. **1**A, FIG. **1**B and FIG. **2** illustrate exemplary embodiments of a turbocharger **110** according to the present invention. Turbocharger **110** is a turbocharger **110** for use in an internal combustion engine. Preferably, turbocharger **110** may be an exhaust-gas turbocharger. Turbocharger **110** has at least one turbocharger housing **112**. Furthermore, turbocharger **110** includes at least one compressor situated inside turbocharger housing **112**, and at least one turbine **114** situated inside turbocharger housing **112**. In addition, turbocharger **110** has at least one sensor device **116** for recording at least a portion of a gas component of an exhaust gas **118** of the internal combustion engine. Sensor device **116** is at least partially integrated into turbocharger housing **112**. Sensor device **116** may include at least one sensor element **120**. In particular, sensor element **120** may be a lambda probe **122**; in general, sensor element **120** may be a probe. For example, sensor element **120** and/or lambda probe **122** may be a lambda probe **122** known from the related art, especially a lambda probe **122** which in the related art is able to be placed in an exhaust-gas tract, preferably upstream from a three-way catalytic converter. Sensor device **116**, in particular sensor element **120**, preferably lambda probe **122**, is able to be positioned in close proximity to the engine, e.g., at an installation position between a manifold, which, for instance, may be situated directly behind the engine in the exhaust-gas flow direction, and turbocharger **110**. According to the present invention, sensor device **116** is at least partially integrated into turbocharger housing **112** of turbocharger **110**. One specific advantage of positioning it near the engine, for instance at least partially integrated into turbocharger housing **112**, may be that, due to hot exhaust gases **118** from the cylinders of the engine at such an installation position, a dew point end is typically able to be reached faster than, for example, in the back in the exhaust track, e.g., downstream from turbocharger **110** in the direction of the exhaust-gas flow.

Turbocharger **110** may include at least one wastegate access, which is not shown in FIG. **1**A, FIG. **1**B and FIG. **2**. It is possible for sensor device **116** to be at least partially situated behind the wastegate access. The term "behind" in particular may indicate a position at a location that lies farther away in the flow direction of exhaust gas **118**.

Sensor device **116** preferably may at least partially be disposed in a volute **124** of turbine **114**. In particular, sensor device **116**, preferably lambda probe **122**, may be situated behind the wastegate access in volute **124** of turbine **114** of turbocharger **110**, e.g., the exhaust-gas turbocharger. The wastegate access may be an exhaust-gas line, in particular, which short-circuits a supply line, especially a supply line of exhaust gas **118**, to turbocharger **110** with a discharge line, especially a discharge line of exhaust gas **118**. For example, an open wastegate, especially a wastegate access, is able to discharge water from volute **124** already following an engine start, during cat-heating, especially the heating of the catalytic converter. This makes it possible, for example, to achieve lower water loading of sensor device **116** and/or sensor element **120** and/or lambda probe **122**. In particular the installation location according to the present invention, especially behind the wastegate access in volute **124** of turbine **114** of turbocharger **110**, offers a protected and/or fixed installation position of sensor device **116** and/or sensor element **120** and/or lambda probe **122**. For example, the proposed installation location, especially the installation location behind the wastegate access in volute **124** of turbine **114** of turbocharger **110**, may allow a more efficient utilization of the engine space. Turbocharger **110** according to the present invention in particular may represent an exhaust-gas turbocharger having an already integrated lambda probe **122**.

Preferably, sensor device **116** is able to be connected to turbocharger housing **112** in reversible manner. The expression "connectable in reversible manner" in particular means that sensor device **116** and/or sensor element **120** and/or lambda probe **122** and/or parts of turbocharger **110** are/is able to be exchanged separately, for example, without causing extensive damage to sensor device **116** and/or to sensor element **120** and/or to lambda probe **122** and/or turbocharger housing **112** and/or to other parts of turbocharger **110**.

Sensor device **116** in particular is able to be screw-fitted with turbocharger housing **112**. Sensor device **116** and/or sensor element **120** and/or lambda probe **122** may be screw-fitted with turbocharger housing **112** using at least one cap screw and/or at least one screw cap, in particular. For example, lambda probe **122** is able to be fixed in place on turbocharger housing **112** by means of at least one cap screw. This provides an in particular directed installation of sensor device **116**, especially lambda probe **122**, with respect to exhaust gas **118**, especially with respect to the exhaust-gas mass flow. Another advantage may be that this makes it possible to increase the dynamic response of a sensor signal, especially a signal from sensor device **116**, for instance during a switch, especially a change, of a partial pressure, e.g., an oxygen partial pressure, in exhaust gas **118**. Because of the fixation of sensor device **116** and/or sensor element **120** and/or lambda probe **122**, especially because of the reversible fixation, e.g., using at least one cap screw and/or at least one screw cap, sensor device **116**, especially lambda probe **122**, is exchangeable, such as in the event of damage. For example, sensor device **116** and/or sensor element **120** and/or lambda probe **122** may be press-fitted with a subassembly, especially with at least a section of turbocharger **110**, using at least one cap screw and/or at least one screw cap, so that, for example, a temperature-sensitive welding seam of the probe, especially of sensor device **116**, is able to be dispensed with. Basically it is possible to mount sensor device **116** on turbocharger housing **112** and/or turbocharger **110** in some other manner as well, e.g., by at least one welding seam.

Using a fixation that employs at least one cap screw and/or at least one screw cap or which uses a press-fit connection, sensor device **116**, such as a probe, may be able to withstand high temperatures.

Sensor element **120** may include at least one first electrode which is acted upon by exhaust gas **118**, and at least one second electrode, and the first electrode and the second electrode are able to be connected via at least one solid electrolyte. Sensor element **120** in particular may be a sensor element **120**, which, for instance, is described in Robert Bosch GmbH: Sensors in the Motor Vehicle, $1^{st}$ edition 2010, pages 160-165.

FIG. **1**A and FIG. **1**B show an exemplary embodiment of turbocharger **110** according to the present invention; a view essentially in the direction of an axle **140** of turbine **114** of turbocharger **110** is shown, in particular. Axle **140** preferably is situated perpendicularly to a rotation plane of turbine **114**. Exhaust gas **118** flows through volute **124**, preferably in clockwise manner, as shown in FIG. **1**B in particular, e.g., in a spiral-shaped motion.

FIG. **2** illustrates another exemplary embodiment of turbocharger **110** according to the present invention, the figure showing a cross-section parallel to axle **140** of turbocharger **110**, especially along axle **140** of turbocharger **110**, in particular.

Sensor device **116** may include at least one shield tube **126**, e.g., at least one guide vane mechanism **128**. It is possible for sensor element **120** to be at least partially situated inside shield tube **126**. Lambda probe **122**, especially together with shield tube **126**, is able to be placed inside turbocharger housing **112**, in particular inside a housing of turbocharger **110**. Shield tube **126** may at least partially be developed in cylindrical shape and/or in block shape, for example, but basically may also have some other form. FIGS. **1**B and **2**, for instance, illustrate one location of shield tube **126**, especially of guide vane mechanism **128**, guide vane mechanism **128** being able to be positioned in volute **124** of turbine **114**, in particular. FIG. **2**, in particular, shows a cross-section of turbine **114**, especially an exhaust-gas turbocharger turbine, especially of turbine **114** of turbocharger **110**.

Shield tube **126**, in particular guide vane mechanism **128**, is able to be designed to route condensate past sensor element **120** and/or past sensor device **116** and/or past lambda probe **122**, preferably without the condensate coming into contact with sensor element **120** and/or lambda probe **122**, especially thermal contact. The condensate, for instance, may be a fluid, in particular, preferably a liquid, especially water. Preferably, shield tube **126** may be designed in such a way that water is able to be routed past sensor element **120**. This specifically reduces the risk of water acting on sensor element **120**, especially lambda probe **122**, and preferably avoids damage to sensor device **116** and/or sensor element **120** and/or lambda probe **122**. For instance, shield tube **126**, especially guide vane mechanism **128**, may be developed in such a way that fluid, e.g, a liquid, especially water, is able to be separated out in advance, in particular a separation of the fluid from exhaust gas **118**. This achieves increased thermal shock robustness, for instance because of shield tube **126**, especially guide vane mechanism **128**.

Shield tube **126**, in particular guide vane mechanism **128**, preferably is able to be connected to turbocharger housing **112** in reversible manner. Sensor device **116**, especially shield tube **126**, e.g., guide vane mechanism **128**, preferably may be implemented to be virtually flush with the wall, e.g., rear volute wall **130**, inside turbocharger **110**, as shown in FIG. **1**B, for example; rear volute wall **130** may be disposed roughly opposite an exhaust gas supply line of volute **124**, for example, but sensor device **116** may also be implemented at a different part of volute **124**. Shield tube **126**, especially vane guide mechanism **128**, may be mounted on turbocharger housing **112**, especially on rear volute wall **130**, in particular by means of at least one cap screw and/or at least one screw cap. For instance, shield tube **126** and/or sensor device **116** may be installed in flat manner, especially in such a way that a flow of exhaust gas **118** and/or an air flow encounter(s) as little interference as possible. Using a guide vane mechanism **128**, a selective flow of exhaust gas **118**, for instance, may be directed toward sensor element **120**, e.g., lambda probe **122**. Through an installation, e.g., of shield tube **126** and/or the positioning of sensor device **116**, an insulating effect of a gap **132**, which, for instance, may exist between sensor element **120** and turbocharger housing **112** and/or shield tube **126**, e.g., in the form of a gas gap and/or air gap, thermal isolation of sensor device **116** and/or sensor element **120** and/or lambda probe **122** or a probe, from a screw-in connecting piece, e.g., the cap screw and/or the screw cap, and/or at least one part of turbocharger housing **112** may be provided. The thermal isolation may reduce the thermal loading of sensor device **116**, in particular, e.g., the probe and/or sensor element **120** and/or lambda probe **122**. For example, shield tube **126** and/or guide vane mechanism **128** and/or sensor device **116** and/or sensor element **120** and/or lambda probe **122** may be fixed in place by being pressed into turbocharger housing **112**, e.g., in a sealing seat. This makes it possible to develop a joint, especially gap **132**, preferably a region between shield tube **126**, in particular guide vane mechanism **128**, and sensor element **120**, especially lambda probe **122** and/or the probe, in protected and/or robust manner.

Shield tube **126** may include at least one inflow opening **134** and/or at least one discharge opening **136**. Shield tubes **126**, especially guide vane mechanisms **128** are shown in FIGS. **4**, **5** and **1**B by way of example. Inflow opening **134** and/or discharge opening **136**, for example, may be developed as holes, such as round holes and/or elongated holes. In FIG. **4**, inflow opening **134** is developed as elongated hole, for example, preferably as slot having a rectangular projection surface on an axial plane of shield tube **126**. Discharge opening **136** is likewise developed as elongated hole in FIG. **4**, especially as elongated hole without corners. It is basically also possible that inflow opening **134** and discharge opening **136** have the same geometry. Both FIG. **4** and FIG. **5** illustrate possible developments of shield tubes **126** which are at least partially implemented in the form of a cylinder. One shield tube **126**, which is shown in FIG. **5**, for instance, preferably may include a round inflow opening **134** and a round discharge opening **136**. Inflow opening **134** may be situated at a radial distance $r_{ein}$ from a center point of turbine **138**. The center point of turbine **138** may be situated on axle **140** of turbine **114**, in particular. Discharge opening **136** preferably may be situated at a radial distance $r_{aus}$ from the center point of turbine **138**. $R_{ein}$ preferably is greater than $r_{aus}$. For example, sensor device **116** and/or rear volute wall **130** are/is able to be placed at a radial distance R from the center point of turbine **138**. A tip of a turbocharger blade **146**, for example, may have a radial clearance $R_{LR}$ with respect to the center point of turbine **138**.

In the exemplary embodiment shown in FIG. **1**B, in particular, inflow opening **134**, marked by an arrow which indicates the flow direction of the incoming exhaust gas **118**, lies at a greater distance from the center point of turbine **138** than discharge opening **136**, two arrows marking the direction of outflowing exhaust gas **118**. The fact that discharge opening **136** preferably is situated closer to the center point of turbine **138** than inflow opening **134** is also shown in FIGS. **4** and **5**, in that discharge openings **136** lie closer to a sealed end of shield tube **126**, especially guide vane mechanism **128**, than inflow openings **134**, the sealed end of shield tube **126** generally representing the part of shield tube **162** that faces away from the mounting position of sensor device **116** on turbocharger housing **112**, e.g., the cap screw and/or the screw cap. The open side of shield tube **126**, especially guide vane mechanism **128**, in particular the side on the mounting position, may likewise be sealed, and preferably include openings, such as for the feedthrough of cables.

FIGS. **3**A and **3**B show a stable pressure distribution and/or a pressure gradient, as it preferably may occur in an exemplary embodiment of a turbocharger **110** according to the present invention, especially in volute **124** of turbocharger **110**. FIG. **3**A, in particular, illustrates radial distances $R_{LR}$ and R of a turbocharger **110**, which is shown here without sensor device **116**. In FIG. **3**B, in particular the ratio of a pressure Δp in relation to a maximum pressure $\Delta p_{max}$ has been plotted by way of example over a distance r, for instance over the radial distance, especially over a radius, r preferably being measurable starting from the center point of turbine **138**. In particular a relative pressure

$$\frac{\Delta p}{\Delta p_{max}}$$

for the radial distances $R_{LR}$, $r_{aus}$ and $r_{ein}$, R, as shown in FIG. **3**A, is plotted. The pressure distribution and/or the pressure gradient in particular may be due to the principle of the axial blower, especially turbine **114**. The stable pressure gradient and/or the stable pressure distribution as it preferably exists in turbocharger **110** according to the present invention, as shown in FIGS. **1**A, **1**B, **2** and **3**A by way of example, may essentially be used as the driving force for a through-flow, in particular, of sensor element **120** and/or shield tube **126** and/or guide vane mechanism **128**, especially a flow approaching sensor element **120** and/or lambda probe **122**, preferably of exhaust gas **118**. Inflow opening **134** of shield tube **126**, preferably of guide vane mechanism **128**, preferably is situated on radius $r_{ein}$, and discharge opening **136** on radius $r_{aus}$, thereby in particular ensuring that a driving pressure gradient and/or a driving pressure distribution exists in all operating points, especially during the entire operation of turbocharger **110** and/or the internal combustion engine, especially from inflow opening **134** to discharge opening **136**. A driving pressure gradient and/or a driving pressure distribution in particular may mean a pressure distribution and/or a pressure gradient at which the pressure essentially decreases from inflow opening **134** to discharge opening **136**, preferably in a continuous manner, since the pressure at $r_{aus}$ is generally lower than at $r_{ein}$, in particular due to a higher flow velocity of exhaust gas **118** at $r_{aus}$ in comparison to $r_{ein}$, for example, especially since $r_{aus}$ preferably may be situated farther away from a wall, especially the volute wall, e.g., rear volute wall **130**, in comparison with $r_{ein}$.

In FIG. **3**B, a principle of the pressure distribution and/or the pressure gradient, especially inside volute **124** of turbocharger **110**, is illustrated by way of example. The relative pressure

$$\frac{\Delta p}{\Delta p_{max}}$$

increases from a distance $R_{LR}$, especially at a tip of a turbocharger blade **146**, across $r_{aus}$ and $r_{ein}$ to R, especially at an outer volute wall and/or at a rear volute wall **130**, usually in an essentially continuous manner. The pressure difference between the position of inflow opening **134** and discharge opening **136**

$$\frac{\Delta p_{Sonde}}{\Delta p_{max}}$$

in particular is able to be read out. Since the pressure at the position of inflow opening **134** $r_{ein}$ preferably is greater than at the position of discharge opening **136** $r_{aus}$, especially as optionally shown in FIG. **3**B, a driving force generally comes about which is able to guide exhaust gas **118** from inflow opening **134** to discharge opening **136**, for instance in a suction-like manner. Distances $R_{LR}$ and R, which may relate to the diagram from FIG. **3**B, are shown in FIG. **3**A, for example. The arrow at an entry to volute **124** in FIG. **3**A in particular indicates the direction of the exhaust-gas mass flow. A pressure gradient preferably may form between the intake and outlet of exhaust gas **118**, especially between inflow opening **134** and discharge opening **136**, and the pressure gradient may cause a mass flow, especially an exhaust-gas mass flow, through shield tube **126**, especially through guide vane mechanism **128**.

For instance, inflow opening **134** and discharge opening **136** may be situated on the same side of shield pipe **126**, as shown in FIG. **5**, for example. It is also possible for inflow opening **134** and discharge opening **136** to be situated on opposite sides of shield tube **126**, as shown in FIG. **4**, for example. Inflow opening **134** and discharge opening **136** may also be situated on different sides. Preferably, inflow opening **134** may be disposed on a side of shield tube **126**, especially on a shell of shield tube **126**, that is exposed to the exhaust-gas flow, and discharge opening **136** preferably may be situated on a side of shield tube **126**, in particular a shell of shield tube **126**, that lies across from the side exposed to the exhaust-gas mass flow.

Inflow opening and discharge opening **136** may be connected to each other, for instance via at least one bypass **142**, preferably via a single bypass **142**. If a bypass **142** is provided, as shown in FIG. **5**, for example, inflow opening **134** preferably may be situated on the same side as discharge opening **136**. The arrows in particular indicate the flow direction of the exhaust-gas mass flow. Bypass **142**, for example, may be developed as exhaust-gas line, especially as pipe, e.g., as bent pipe. Bypass **142** in particular may have a wall opening **144**, in order to have exhaust gas **118** act on sensor element **120**, especially lambda probe **122**. Optionally, bypass **142** may be disposed on shield tube **126**, in particular on guide vane mechanism **128**, especially between the intake and outlet, e.g., between inflow opening **134** and discharge opening **136**. For example, bypass **142** may be designed to realize a high flow velocity at a small exhaust-gas mass flow. This makes it possible to achieve a high dynamic response of sensor element **120**, for example, especially the sensor signal, and/or to prevent cooling of sensor element **120**, e.g., lambda probe **122**, especially at the same time.

Turbine **114**, for instance, may include at least one turbocharger blade **146**. In addition, turbocharger **110** according to the present invention may have at least one pressure bore **148**, as shown in FIG. **2**. The installation position of sensor device **116**, especially sensor element **120**, especially preferably, lambda probe **122**, may constitute a protected installation position, in particular. Inflow opening **134** may be developed as intake, in particular, and discharge opening **136** may be developed as outlet. Sensor element **120**, especially the lambda probe, as illustrated in FIGS. **1**B, **4** and **5**, may be disposed in shield tube **126** in centered manner, in particular. It is basically also possible to install sensor element **120** in laterally shifted or rotated manner. Shield tube **126**, especially sensor element **120**, may be positioned perpendicularly to a wall of turbocharger housing **112**, especially in relation to rear volute wall **130**. “Perpendicular” in this context in particular may mean an angle between 70° and 110°, preferably between 80° and 100°, especially preferably of approximately 90°. In principle, shield tube **126** may also be disposed at another angle relative to a wall of turbocharger housing **112**, especially with respect to an axis of symmetry of shield tube **126**. Basically, sensor device **116** is able to be positioned at any location of turbocharger **110**, preferably in such a way that sensor element **120** is able to be acted upon by exhaust gas **118**.

What is claimed is:

**1**. A turbocharger in an internal combustion engine, comprising:

at least one turbocharger housing;

at least one compressor situated inside the at least one turbocharger housing;

at least one turbine disposed inside the at least one turbocharger housing; and

at least one sensor device for detecting at least one portion of a gas component of an exhaust gas of the internal combustion engine, wherein the at least one sensor device is at least partially integrated into the at least one turbocharger housing, and wherein the at least one sensor device is at least partially situated inside a volute of the turbine.

**2**. The turbocharger as recited in claim **1**, wherein the at least one sensor device is connected to the at least one turbocharger housing in a reversible manner.

**3**. The turbocharger as recited in claim **2**, wherein the at least one sensor device is screw-fitted with the at least one turbocharger housing by at least one of a cap screw and a screw cap.

**4**. The turbocharger as recited in claim **1**, wherein:

the at least one sensor device includes at least one sensor element configured as a lambda probe having a first electrode and a second electrode;

the first electrode is configured to be acted upon by the exhaust gas; and

the first electrode and the second electrode are connected via at least one solid electrolyte.

**5**. The turbocharger as recited in claim **4**, wherein the at least one sensor device includes at least one shield tube, and the at least one sensor element is at least partially situated inside the at least one shield tube.

**6**. The turbocharger as recited in claim **5**, wherein the at least one shield tube is configured to route a condensate past the at least one sensor element.

**7**. The turbocharger as recited in claim **6**, wherein the at least one shield tube is connected to the at least one turbocharger housing in a reversible manner.

**8**. The turbocharger as recited in claim **6**, wherein the at least one shield tube includes at least one of an one inflow opening and a discharge opening, the at least one inflow opening being at a selected first radial distance from a center point of the at least one turbine, and the discharge opening being situated at a selected second radial distance from the center point of the at least one turbine, the first radial distance being greater than the second radial distance.

**9**. The turbocharger as recited in claim **8**, wherein the at least one inflow opening and the discharge opening are situated on a same side of the shield tube.

**10**. The turbocharger as recited in claim **8**, wherein the at least one inflow opening and the discharge opening are connected to each other via a bypass.

**11**. The turbocharger as recited in claim **8**, wherein the at least one inflow opening and the discharge opening are situated on different sides of the at least one shield tube.

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